

SURVEY OF THE VERTEBRATE FAUNA OF THE DOTSWOOD AREA, NORTH QUEENSLAND

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The results of a survey of mammals, birds, reptiles, amphibians and fish of the Dotswood area west of Townsville are presented. Habitats included in the survey were woodland, open forest, tall open forest, closed forest (rainforest), riparian forest and rocky outcrops. A total of 297 species of vertebrates were observed using a variety of survey techniques including live trapping, pit trapping, observational transects, mist netting and spotlighting. Exact locations of observations and indices of relative abundance of each species are included.
☐ Survey, vertebrate, mountain, Dotswood, north Queensland, Australia.

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Fauna surveys, although mostly descriptive, are a basic necessity in the understanding of the ecology of any area. This paper describes a broad survey of the vertebrates in a variety of habitats west of Townsville, undertaken to provide baseline information prior to the proposed development of military training facilities. Despite its proximity to and accessibility from Townsville, the survey area, which includes Dotswood Station, Star Station, High Range Training Area and sections of the Bluewater Range, had never been the subject of any intense biological studies. Consequently, very little published biological information exists for the area. Not only is information on the area poorly represented in the literature, but the wet-dry tropical environment of north Queensland which typifies much of the Dotswood and High Range areas is very poorly understood. This reflects the concentration of Australian zoological and ecological research effort in southern regions and the tropical coastal zone in the past.

The study area is located within the Shire of Dalrymple to the south-west of Townsville (Fig. 1), with the north-eastern and eastern boundaries following the escarpments of the Paluma and Hervey's Ranges. The western boundary is to the west of the Star River and the southern boundary follows the boundary between Dotswood Station and Fanning River Station (Fig. 2).

The total study area of about 2320km² comprises the following land tenures:

High Range Training Area (HRTA)	48,669ha
Dotswood Pastoral Lease (No. 44/3176).	155,000ha

Special Lease RAAF training area (N 44/45266)	27,300ha
Occupational License (No. 510)	907ha
Total study area approximately	232,000ha

The landscape descends from the escarpments and hills of Paluma and Hervey's Ranges (altitude c.800m) in the north and east to a complex of dissected plateaux and tablelands with steep slopes to the south, through to areas of low relief (altitude c.250m) in the south-west. The study area is drained by the Star River, Keelbottom Creek, Fanning River and the Reid River. Drainage direction is generally to the south, with all drainage systems except the Reid River draining into the Burdekin River. The Reid River flows into the Haughton River.

The emphasis of the study was on recording the diversity of the vertebrate fauna in each of the major habitat types of the study area, with some regard to relative abundances. Sampling methods were therefore designed to record as many species of mammals, birds, reptiles, amphibians and fish as was possible. Additionally, literature on the study area was reviewed and a reasonably comprehensive species list of the area was compiled.

Additional sources of information included rare and threatened species lists from Queensland National Parks and Wildlife Service (QNPWS); endangered species list from ANZECC (Anon, 1991); assessments of status and lists of rare, endangered, vulnerable and poorly known vertebrates of Queensland, and location records of mammal, bird, reptiles and frogs from the Queensland Museum database (Ingram & Raven,



FIG 1. Map of north Queensland showing location of study area.

1991), the most up-to-date assessment of the status of vertebrates in Queensland; species records from the Wildlife Preservation Society of Queensland; Williams et. al., (1993); Ben Lomond . (Hollingsworth, 1980); Brouwer & Garnett's (1990) annotated list of threatened birds of Australia; and a variety of personal communications with staff at James Cook University and the QNPWS.

LITERATURE REVIEW

BIRDS

Most bird records from the region are from the coastal plains and ranges. Lavery & Johnson (1968) provided a list of observations from the Townsville area, from Mt Spec in the north to 'St Hellions' near Cape Cleveland in the south. This study identified 229 species from the area. Blakers et. al. (1984), which provided Australia-wide maps for all the Australian birds mapped in $1^{\circ} \times 1^{\circ}$ squares ($19^{\circ}\text{S } 146^{\circ}\text{E}$), recorded 256 spp. from the region encompassing the study area. Nix & Switzer (1991) gave locality and expected ranges of all vertebrates considered to be endemic to the wet tropical rainforest. Steve Garnett (pers. comm.) listed 365 species from the Townsville area and Hollingsworth (1980) listed 64 bird spe-

cies at the Ben Lomond mine on Dotswood. Queensland Museum specimen records are scanty, including only three species from the Dotswood area.

Due to the relative ease of observation and identification of birds, they feature strongly in the lists of amateur wildlife groups, such as, the Townsville Bird Banding Group, which has undertaken a long term study in tall open forest west of Paluma, and the Wildlife Preservation Society of Queensland, which provides bird lists in excursion reports from the Townsville area, including Bluewater and Hervey's Ranges and Fanning River. In addition, QNPWS provide bird lists for national parks of the area including Mt Spec and the Townsville Town Common. Where relevant, species recorded by these sources have been included in this report.

Ecological studies in the area are much scarcer than simple records of occurrence. Apparently no studies have been conducted within the study area itself or within equivalent open forest in the region. Keast et. al. (1985), however, bring together information on eucalypt forest birds, some of which may be applicable to this area (e.g. Keast, 1985; Recher, 1985).

Rainforest birds have received more attention in north Queensland. Kikkawa (1982) examined the community structure of rainforest birds in relation to rainforest physiognomy and Crome (1978) examined the feeding ecology of birds in lowland rainforest. Although these studies were conducted at lower altitudes than the study area their results should be applicable to rainforest on the Bluewater Range. However, while some studies have been conducted in comparable areas and may be applicable to the study area, information on habitat utilisation, particularly the role of wet refugial areas (i.e. riverine and vine thicket habitats, and responses to disturbance) is scanty. Stocker & Irvine (1983) and Crome & Moore (1990) have discussed the ecological role of the Southern Cassowary in dispersal of rainforest seeds.

MAMMALS

Winter et. al. (1984) provided a list of 16 rainforest mammal species either recorded or expected from the Bluewater region which is partly contained within the RAAF training area. Lavery & Johnson (1968) gave a list of 71 mammals from the coastal plains and ranges of the Townsville area. No equivalent published lists are available from the drier habitats that typify most of the study area, although Hollingsworth (1980) listed

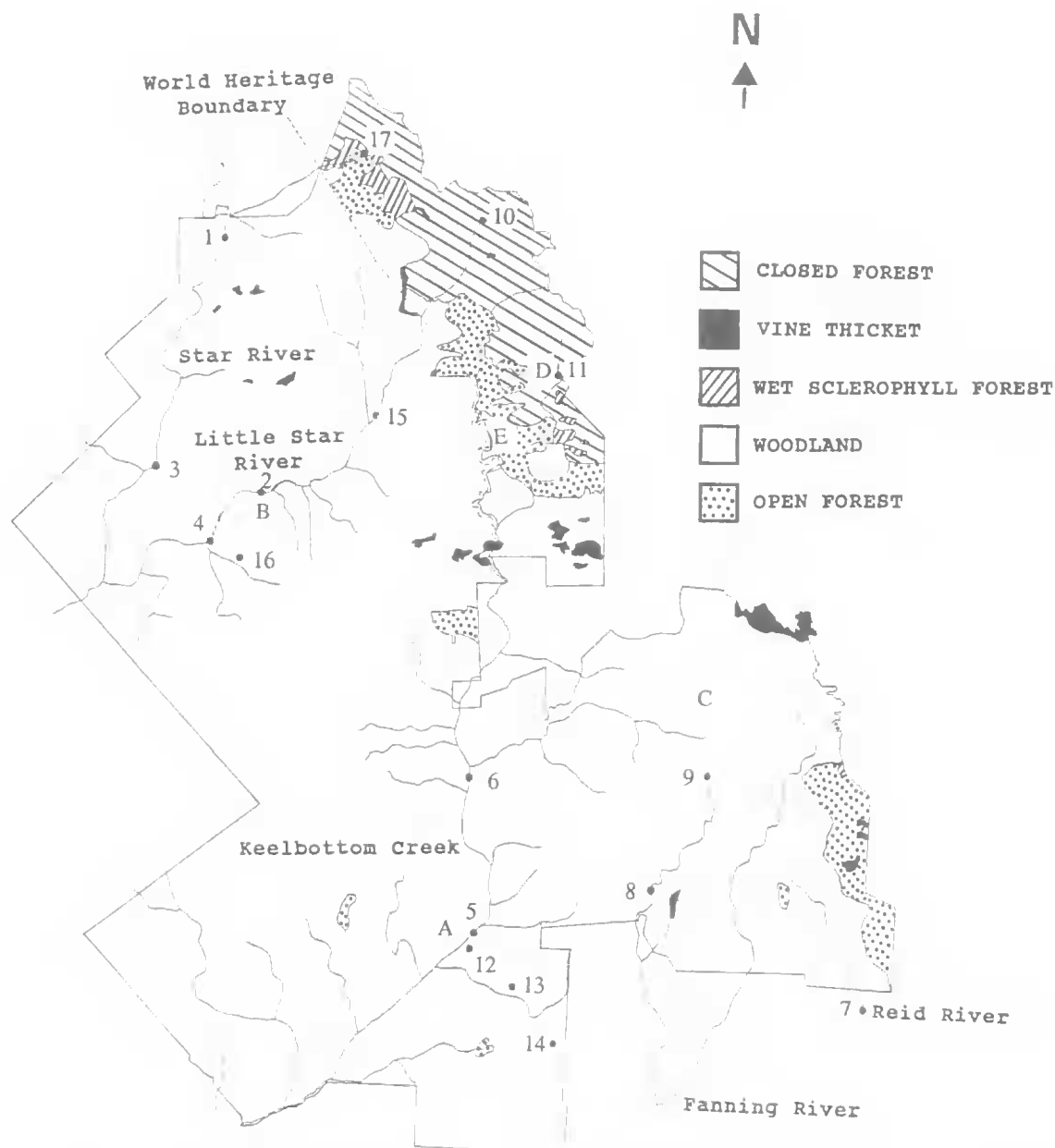


FIG 2. Map of the study area showing site locations and major fauna habitat types and streams (riparian habitat). Major vegetation boundaries after Power & Jackes (1992).

13 mammal species, five of which were introduced, at the Ben Lomond mine site on Dotswood. A QNPWS survey of the Dalrymple Shire covers an area of comparable habitats to the west of the study area, but the results of this survey were not available.

Queensland Museum records provide a list of

nine species from Hervey's Range and areas on Dotswood Station while QNPWS provide lists for Mt Spec National Park and Townsville Town Common Environmental Park, which may be applicable to wetter parts of the Dotswood area. At Mt Spec, near Paluma, Williams (1990) examined the relationships between mammal commu-

nities and vegetation in wet forests similar to those in the study area at Bluewater State Forest.

REPTILES

Like mammals, reptiles are mostly cryptic and there is considerable confusion surrounding the taxonomy of many groups. Therefore it is not surprising that, until recently, very little had been published on the distribution and population and community ecology in this group (Strahan, 1985). However, Greer (1989) provided summaries of information on species biology for the lizards.

Queensland Museum records list 27 species of reptiles from the Bluewater/Hervey's Range/Dotswood area and Hollingsworth (1980) listed 23 species at Ben Lomond mine on Dotswood. Both these numbers are probably poor reflections of the true reptile diversity of the area as gleaned from distribution maps (Cogger, 1992; Wilson & Knowles, 1988).

The recent upsurge in interest in the wet tropics has led to increased collecting activity in the area. As a result, the distribution and status of rainforest species is generally better understood than for the species of the drier forest and woodland to the west (e.g. Nix and Switzer 1991). However, for the vast majority of reptiles from this area, and indeed from most of Australia, very little is known of community ecology or of specific habitat requirements (e.g. Wilson & Knowles 1988). The responses of species and communities to natural and human disturbances is unknown.

AMPHIBIANS

A considerable increase in interest in frog ecology and taxonomy has happened in the past 20 years (McDonald, 1992; Covacevich & McDonald, 1991; Ingram & Raven, 1991). This increase is reflected in an increase in the number of taxonomic studies (e.g. Czechura et. al., 1987; Liem 1974; Zweifel 1985) and, coupled with recent interest in the wet tropics, has led to a reasonable understanding of rainforest frog distribution patterns. McDonald (1992) provided a list of 23 rainforest species, 21 of which were endemic to tropical rainforest in north Queensland. Of this list, five, all with conservation prognoses of very good or excellent, are recorded from the Bluewater Range. A further five species are recorded on Queensland Museum lists from the drier areas of the study area and six species are listed from the Ben Lomond mine site on Dotswood Station (Hollingsworth, 1980).

Tyler (1979) described our knowledge of Australian frogs as abysmal and, although they have

received much more attention since that time, our understanding of population and community ecology is still at a basic level, especially in the wet/dry tropics. He listed potential impacts of humans on frogs including deforestation, land drainage, introduction of predators (including aquatic predators), and siltation of water bodies. Some species have benefited through human activities including provision of water bodies in dry areas. Habitat utilisation, including, for example, the importance of wet refugial areas, is not known.

FISH

Published material on the aquatic biota of the region is scarce. Pearson (1991a) reviewed much of the available information and discussed some of the major research needs for the wet tropics forest area. There is some information produced by the QNPWS for the coastal wetlands near Townsville, mostly on the avifauna, and one or two publications on the limnology of the Ross River Dam (e.g. Finlayson & Gillies, 1982). However, these coastal wetlands are not comparable with the natural aquatic habitats in the study area. The ecology of the middle Burdekin River has been studied by a research team at James Cook University, but apart from a short report (Pearson, 1991b) this work remains unpublished. Current studies on fish communities in the Star and Fanning Rivers include sites within the study area, but the work is incomplete and unpublished (B. Pusey, pers. comm.).

Studies of streams in the drier areas comparable with the study area are limited. They include the work on fish communities in the Black River (Beumer, 1980), on catfish populations in Campus Creek, an intermittent stream on James Cook University campus (Orr & Milward, 1984), and on the invertebrate communities of Campus Creek (Smith & Pearson, 1984, 1987).

It is clear, therefore, that the wet/dry forests and woodlands to the west of the wet, coastal ranges have been largely ignored in comparison to the rainforests. Additionally Ridpath (1985) noted that far less research has been conducted into ecological processes of the wet/dry tropics than in temperate or arid regions of Australia. He also pointed out the dangers in trying to apply models from these areas to the wet/dry tropics.

SAMPLING SITES

TERRESTRIAL

Site selection was aimed at replicated sampling of the maximum number of habitat types possible

within the constraints of time, equipment and personnel. The following broad habitat types were identified within the study area from the vegetation map by Power & Jackes (1992) (Fig. 2) and their detailed vegetation descriptions:

CF: closed forest;

TOF: tall open forest or 'wet sclerophyll forest';

OF: open forest;

W: woodland;

R: riverine (riparian) forest;

RK: rocky outcrops;

SW: swamps and other water bodies;

G: grasslands, mostly artificially cleared;

A pilot survey was used to ground-truth the habitat types and to select sampling sites within each broad vegetation type (Fig. 2). Within each of these sites, three or four different sub-sites were selected for intensive sampling. These sub-sites were chosen to maximise the diversity of habitats sampled within each broad vegetation type. The sites were (grid references refer to Australian 1:50 000 topographic maps, series R733):

SITE A: Woodland (W), vicinity of Dotswood homestead. This site is representative of the large areas of *Eucalyptus crebra* open woodland that cover most of the study area. Three sub-sites were: A1 - riparian vegetation along Keelbottom creek (19°37'S 146°19'E; grid ref. DU 247293); A2 - open woodland with grass understorey (19°36'S 146°17'E; grid ref. DU 227314); and A3 - open woodland with a shrub layer of *Acacia* sp. and grass understorey (19°35'S 146°15'E; grid ref. DU 216330).

SITE B: Woodland (W), between Star homestead and Ponto Hut. This second open woodland site was selected because this vegetation type covered a large proportion of the study area and the fauna might differ between the northern (site B) and southern (site A) areas. Three sub-sites were: B1 - low open *E. shirleyi* woodland with low shrubs along small dry gullies (grid ref. DU 151635); B2 - riparian vegetation (R) along the Little Star river and *E. platyphylla* woodland with dense grass layer (*Heteropogon* sp.) (19°18'S 146°12'E; grid ref. DU 149647); B3 - *E. crebra* open woodland with grassy (*Heteropogon* sp.) understorey (19°19'S 146°18'E; grid ref. DU 206645); B4 - mixed *Eucalyptus* open forest with sparse grass, predominantly *Themeda* sp.

SITE C: Open forest and woodland (OF and W) in the High Range training area. This area consists of denser vegetation than sites A and B with a greater tree diversity. The area is hilly with some rocky outcrops. Four sub-sites were: C1 - *Melaleuca* swamp with sedge and blady grass understorey (19°23'S 146°29'E; grid ref.

DU466554); C2 - riparian vegetation along Stake Creek (major tributary of the Fanning river) (19°27'S 146°30'E; grid ref. DU 480481); C3 - Rocky outcrop (19°27'S 146°30'E; grid ref. DU 402482); C4 - open eucalypt forest with grass (*Themeda triandra*) understorey (19°31'S 146°33'E; grid ref. DU 532427).

SITE D: wet sclerophyll forest (TOF) and closed forest (CF) (Bluewater State Forest). This transitional habitat is very narrow and patchy and not readily distinguished in air photos. Dominant tree species are *Syncarpia glomulifera*, *Allocasuarina* sp. and *E. grandis* and there are also several other eucalypts and a variety of rainforest species. The rainforest species often form a shrub layer under the emergent sclerophyll species. This habitat represents an ecotonal area between rainforest and the open eucalypt forest to the west. Three sub-sites were selected on the basis of differing vegetation structure: D1 - closed *Allocasuarina*/*Syncarpia* forest with dense shrub layer and very little ground cover (19°14'S 146°24'E; grid ref. DU371734); D2 - *Allocasuarina*/*Syncarpia*/*Eucalyptus* forest with some shrubs (predominantly rainforest species) and short, dense grass (19°14'S 146°23'E; grid ref. DU 365731); D3 - *Syncarpia*/*E. grandis*/*Allocasuarina* forest with dense ground cover of blady grass and sedges and also some patches of dense shrubs (19°14'S 146°23'E; grid ref. DU 359725). D4 - *Allocasuarina*/*Eucalyptus* open forest with dense ground cover of *Xanthorrhoea*, *Imperata* and areas of shrubs. *Pandanus* sp. occur in low lying wetter areas. A rainforest sub-site was not sampled due to previous survey work on Mount Halifax which is less than 1 km outside the study area (Williams et al., 1993).

SITE E: open Forest (OF) (19°17'S 146°22'E) on the western side of the Bluewater range. This site is a transitional zone between the dense, wet sclerophyll forest of site D and the eucalypt woodland of site B. The vegetation grades from Tall Open forest with *Eucalyptus grandis*, *Syncarpia glomulifera* and *Allocasuarina torulosa* dominants, through a mixed eucalypt open forest (*E. citriodora*, *E. peltata*, *E. shirleyi* and others) to Ironbark woodland near West Keelbottom creek. Riparian vegetation along the creek consists of patches of closed *Tristanopsis exiliflora* gallery forest and more open *Callistemon* spp./*Melaleuca* spp. forest. Further upstream there are several vine thickets, which were investigated. The various areas sampled at this site have been combined because of their close proximity and because the site was only sampled once.

Major terrestrial habitat types and associated samples were therefore as follows:

Open woodland: A2, A3, B1, B3

Open forest: B4, C1, C4, D4, E

Tall open forest/closed forest: D1, D2, D3

Riparian: A1, B2, C2, E

TABLE I. Fish sampling sites and their major physical characteristics. Ref, grid reference, I:100000 series; Hbt, habitat (P = pool, R = riffle); Temp, temperature (C); D.O., dissolved oxygen (mg/L); Cond, conductivity ($\mu\text{S}/\text{cm}$); Dpth, maximum depth (cm); Wdth, maximum width (m); Subst, major substratum (B = bedrock, RR = large rocks, R = small rocks, G = gravel, S = sand, L = leaf litter; % indicates proportion of substrate damaged by hoofed animals); Curr, current velocity (cm/s); Vegetation: Mel = riparian *Melaleuca* overhanging, W = ironbark woodland, Cal = riparian *Callistemon*, OF = open *Eucalyptus* forest. CF = closed forest.

Site	Ref	Hbt	Temp	D.O.	Cond	pH	Dpth	Wdth	Subst	Curr	Vegetation
1 Star	DU126841	P	22.3	6.7	108	6.9	40	12	RR,R,G,S	3	Mel, wdInd
		R	22.2	7.1	101	7.0	18	9	R,S	6	Mel, wdInd
2 Little Star	DU151635	P	19.5	7.0	221	7.4	200	15	R,S		Mel, wdInd
		R	19.8	7.0	213	7.1	18	3	R,G,S	15	Mel, wdInd
3 Star	DU084681	P	-	-	-	-	-	200	75	S,L	0
				23.6	8.3	-	-	-			
				21.6	11.8	58	8.3 0.3	-			%
4 Little Star	DU120617	P	20.2	8.8	176	7.6	50	5	R,S,L	0	MelwdInd
		R	20.5	8.9	163	7.5	15	5	R,S		-
5 Keelbottom	DU247293	P	22.6	-	420	7.9	30	5		R,S,L	0
		R	22.0	8.4	437	7.9	25	4	RR,R,G,S,L	10	
6 Keelbottom	DU301448	P	20.7	7.3	465	7.6	40	3	R,S	0	Mel, OF
		R	21.0	7.9	393	7.7	35	6	R,G,S	30	
7 Reid	DU598275	P	28.1	5.1	671	8.6	400	15	B	0	Mel,Cal,OF
		R	26.0	6.8	-	8.1	6	1			R
			23.6	8.3	411	7.7 150		<10%			
8 Fanning	DU421346	P	22.9	7.3	957	8.4	60	10	R,S,L	2	Mel,OF
		R	24.5	7.3	1240	8.8	20	3	R	50	Mel,OF
9 Stake	DU480481	P	22.5	8.1	164	8.4	35	12	R,G,S,L	0	Mel,Cal,OF
10 Little Star	DU334808	P	14.0	11.1	42	-	35	6	R,S,L	0	CF
		R		13.0	10.4	48	7.2	15	5	RR,R,S	20
11 Keelbottom	DU341786	P	15.5	8.3	42	5.7	25	4	RR,R,S,L	0	CF
		R	14.8	8.0	44	5.4	25	4	R,S	30	CF
			20.0	6.4	37	6.5 180		<10%			
12 Dtswd wetInd	DU248290		-	-	-	-	-		10-30%		
13 Dtswd dam	DU272272		27.2	9.7	102	8.8	40		30-70%		
14 Dtswd dam	DU275256		24.7	9.2	94	8.5	220		<10%		
15 L.Star Ponto DU244700		21.9	10.7	118	8.2	30				%	
16 Star Sin.dam	DU134605		23.3	8.2	187	8.3 180				%	
17 Star	DU272865		20.0	6.4	37	6.5 180					

Rocky outcrops: C3

Observations were not restricted to these sites, however, and our records are supplemented by information from extensive observations across the study area. For example, while there was only

one rocky outcrop sampling site, general observations were made wherever rocky outcrops were encountered, and are incorporated in our composite species lists.

The extent of some habitat types did not warrant

the status of major sites, and were therefore only sampled opportunistically. For example, grassland had mostly been previously cleared land and was not extensive.

STREAMS

Because of the highly seasonal climate, the streams are seasonal, and surface flow ceases in most of them in the dry season. However, most of the streams have permanent pools. The streams range from upland, rocky, high gradient channels under complete canopy cover to the low gradient, open sandy channels on the south western plain.

Seventeen major sites were selected (Fig. 2) to represent stream and other wetland types across the study area. The grid references and major physical features of the sites are listed in Table 1. In April the streams were running well. In the second survey (September 1991) most streams had ceased to flow and remained only as pools.

The major stream sites were located, from north west to south east, on the Star River (sites 1 and 3), the Little Star River (sites 2, 4 and 10), Keelbottom Creek (sites 5, 6 and 11), Fanning River/Stake Creek (sites 8 and 9) and Reid River (site 7).

The data in Table 1 broadly illustrate the range of sites sampled, from the low pH, low conductivity, cool rainforest streams in the north (sites 10 and 11) to the warmer, high pH, high conductivity woodland streams in the south east (sites 7, 8 and 9). Differences between the sites reflect several variables, including climate and vegetation, and geology. For example, the streams in the south east included deposits of calcium carbonate in their catchments, which leads to the alkaline water with high conductivity, while those in the rainforest were based on granitic bedrock and soils and had low levels of dissolved substances in them.

SAMPLING METHODOLOGY

TERRESTRIAL FAUNA

The sampling strategy was designed to capture or observe the highest diversity of vertebrates possible. Given the time constraints, assessments of absolute densities were given lower priority. A variety of techniques were employed, all of which proved to be useful. Sampling effort was standardised in order to render intersite data as comparable as possible. However, differences in weather, terrain and vegetation all affect the efficiency of sampling. These effects include greater difficulty of observation within dense forest, re-

duced visibility and/or animal activity during periods of rain or heavy mist, reduction of frog and reptile activity as the weather became cooler and drier, and inability to sample intensively in areas where vehicular access was not possible.

Two surveys were conducted: 8 April-3 May 1991 (site A-D); and 7 August-25 October 1991 (sites A-E). A total of 63 days were spent in the field (approximately 146 person days).

Literature consulted to aid identification were Strahan (1983), Cogger (1986), Hall and Richards (1979), Kitchener and Caputi (1985), Simpson and Day (1984), and Pizzey (1980).

TRAPPING

Three trapping techniques were utilised:

Elliot traps - 100 Elliot traps (type A), divided equally between the sub-sites, were set over three or four nights at each site. Traps were set 10m apart and alternatively baited with oats and vanilla essence, or oats and peanut butter or oats/peanut butter/sardines. These traps are designed for capturing mammals up to the size of rats. Twenty 20 cage traps (bandicoot size) were set with the Elliot traps, equally divided among sub-sites and equally spaced along the trapping lines. These traps were baited with sardines, rolled oats and vanilla essence and were designed to capture medium-sized mammals, e.g. *Isodon macrourus*. Additionally, 20 large cage traps (cat size) were used at site D in the rainforest. These traps were baited with meat, in an attempt to capture large predators, specifically quolls (*Dasyurus maculatus*), which were known from anecdotal evidence to have occurred at Paluma at least until the 1950's.

Pit traps are suitable for capturing a variety of small mammals, reptiles and amphibians and 30 (20 litre drums) were installed at sites A and B. Five drift fences 10m long and each with two pits were set up at each sub-site (i.e. 10 pits per sub-site \times 3 sub-sites = 30 pits and 150m of drift fence per site) at sites A and B. Pit trapping had also been conducted previously in rainforest on Mt Halifax, just outside the study area (Williams et al., 1993). Pit traps were not used on the other sites because it was found during the first survey of sites A and B that the results were not sufficient to justify the time spent installing them.

SPOTLIGHTING

Spotlighting was conducted every night in the field and totalled eight nights per site. Each sub-site was spotlighted at least one night per trip for approximately 1.5hr. Additionally general sur-

TABLE 2. The diversity of vertebrate fauna within the study area. Species previously recorded in the region and which possibly occur within the study area are included (sources of previous records include Lavery & Johnson 1968, 1969, Blakers *et al.* 1984, Winter 1984, Queensland Museum records, QNPWS Mt Spec species list, Garnett (pers. comm.). Sources of possible records are Strahan, 1983; Cogger, 1986; Readers Digest, 1976; Simpson and Day, 1984. Species listed as previously recorded have not necessarily been recorded within the study area, but have been recorded in the near vicinity. Only records of species which are likely to be present (on the basis of available habitat types) have been included.

TAXONOMIC GROUP	OBSERVED	PREVIOUSLY RECORDED/POSSIBLE
MAMMALS		
# Families	18	20
# Species	50	62/76
BIRDS		
# Families	52	66
# Species	180	282/282
REPTILES		
# Families	8	10
# Species	38	64/114
AMPHIBIANS		
# Families	4	4
# Species	16	29/26
FISH		
# Families		
# Species		

veys were conducted at each site. Most of the spotlighting was conducted along tracks using a 150w handheld spotlight from a vehicle, this being the best method for arboreal mammals in the open woodland. Walking transects, using two 30w handheld spotlights and low power torches were conducted in areas inaccessible by vehicle (e.g. along the creeks) and in areas of denser vegetation.

MIST-NETTING

Mist netting was undertaken every night in the field to capture bats, but was limited by time and the availability of suitable sites, namely potential flight corridors and water bodies. Netting was conducted for about 2hr commencing at dusk. The nets were usually set above a suitable creek or dam, or across a road (in rainforest at Bluewater). Sites netted were: Keelbottom creek (site A, 19°37'S, 146°17'E; grid ref. DU 247293); Cockatoo dam (site A, 19°34'S, 146°15'E; grid ref. DU 206359); Sandy creek (site A, 19°30'S, 146°15'E; grid ref. DU 215339); Little Star river (site B, 19°18'S, 146°12'E; grid ref. DU 151635); Dinner

Creek (site B, 19°23'S, 146°11'E; grid ref. DU 154566); Star River (site B, 19°17'S, 146°07'E; grid ref. DU 081670); Stake Creek (site C, 19°27'S, 146°30'E; grid ref. DU 479481); Dip Creek (site C, 19°26'S, 146°32'E; grid ref. DU 509511); Keelbottom creek - Bluewater (site D, 19°14'S, 146°23'E; grid ref. DU 365731); Bluewater forestry road (site D, 19°14'S, 146°24'E; grid ref. DU 375732); unnamed creek (Star 8159-3, 19°30'S, 146°15'E; grid ref. DU 206443).

BIRDS

Bird species were recorded on a daily basis using several methods. Early morning (dawn) observations were made at each site using both calls and direct observation. Observations were also made while clearing the trapping lines each morning. Each sub-site was also sampled by at least one complete afternoon of bird censusing. Nocturnal birds were recorded using calls and during spotlighting transects. All incidental bird observations were also recorded. Any accessible dams or swamps were visited to record water birds.

ACTIVE SEARCHING

Active searching is simply a collective term for a number of activities aimed at finding and capturing cryptic fauna. This includes miscellaneous observations from vehicles or on foot, as well as rolling logs and rocks, searching under bark and inside hollow limbs of dead trees, capturing by hand any lizards or snakes seen, searching hollow trees and under bridges for bats, and searching any piles of tin or timber. These activities are difficult to standardise, but nevertheless are very useful in supplementing species records (especially reptiles).

While every effort was made to standardise sampling within and between sites, it should be noted that spatial and temporal variation in climate, geography and vegetation affected the visibility and/or catchability of different species as well as imposing differing logistic constraints on our sampling routine. For example, at site E, vehicle access was extremely limited and so sub-sites were much closer together than at other sites.

Fish sampling was done at 11 stream sites and during both surveys, in April and September. Four sampling methods were used:

Seine netting: pools were swept 2-5 times using an 8.0m seine of 10mm mesh. The success of the seine netting was variable, depending on the physical characteristics of the individual pools.

TABLE 3. Number of species of terrestrial vertebrates (excluding feral species) observed during field surveys of the study area by site (habitat).

	SITE A	SITE B	SITE C	SITE D	SITE E
	Ironbark Woodland	Mixed Eucalypt Forest	Wet Sclerophyll Forest	Mixed OF/W	
MAMMALS	27	15	22	16	10
Ex bats	14	11	15	10	8
BIRDS	79	84	82	92	52
Ex open water	79	64	70	90	49
REPTILES	13	8	13	15	8
AMPHIBIANS	9	8	8	4	5
TOTAL	128	115	125	127	75

However, most of the small active fish were recorded using the seine nets.

Fixed net: a 50m fixed net (50mm mesh) was employed at any site which had a large enough pool. The fixed net was useful in catching some of the larger fish and turtles.

Baited lines: baited lines were used in larger pools and were also useful in catching some of the larger species of fish, turtles and eels.

Dip net: weed beds and snags were swept with a hand held dip net to catch small fish such as gudgeons, ambassids, hardyheads and catfish.

Following identification, fish were returned to the water.

In general no voucher specimens were taken. However, specimens of difficult to identify species were taken and checked by dissection (small mammals and fish). The small mammals (*Rattus fuscipes*, *Melomys cervinipes*, and *M. burtoni*) were sent to the Queensland Museum.

RESULTS AND DISCUSSION

A total of 297 species of vertebrates from 91 families were recorded during the fauna surveys. This diversity is not surprising considering the large area and the diversity of habitats included in the area. High diversities of mammals (50 species) and birds (180 species) were recorded, but the diversities of reptiles and amphibians were certainly underestimated because the surveys were conducted outside the wet season. Table 2 summarises the diversity of vertebrate fauna by major taxonomic groups including those species previously recorded in the region and which are likely to occur within the study area.

Table 3 summarises the diversity of terrestrial vertebrates observed by site. In effect, this partly summarises diversity by habitat type, as sites A and B represent Ironbark woodland, site C represents the mixed eucalypt open forest, and sites D and E are a mixture of closed forest and tall open

forest (i.e. the transitional zone between rainforest and open forest).

Total numbers of terrestrial vertebrates was surprisingly similar for sites A, B, C and D. The diversity was lowest at site E, but this was primarily due to a lower sampling intensity.

MAMMALS

The 50 species recorded during the surveys (Appendix 1), plus the 11 extra species from other records represent a large proportion (80%) of approximately 76 species that might possibly occur in the area. Mammal diversity was highest in the more open woodland and eucalypt forests of sites A, B and C. This was due to higher observed diversities of bats, arboreal marsupials and macropods in the open forest/woodland sites.

BIRDS

Bird diversity was highest in the wet sclerophyll forest of site D. The higher bird diversity of this forest is especially noticeable if waterbirds are removed from consideration. The number of species recorded during this study (180) (Appendix 1) represents 64% of the 282 species known from all sources to occur in, or in similar habitats close to, the study area. Given (i) the extent and duration of the survey, (ii) the high mobility of birds (which usually leads to a large number of vagrants being recorded in geographical species lists) and (iii) the absence of a number of summer species during the period of field work, this species count is high.

A sighting of a Grey Falcon in open forest at site E was the only observation of a bird listed as rare. Two other rare species previously recorded in the vicinity are the Red Goshawk and Square-tailed Kite. Southern Cassowaries are presently listed as vulnerable.

There are 13 species of bird which are endemic to the north Queensland tropical rainforest (Crome & Nix 1991), and 11 of these were observed during the survey: Mountain Thornbill,

Bridled Honeyeater, Macleay's Honeyeater, Pied Monarch, Bowers Shrike-thrush, Grey-headed Robin, Northern Logrunner, Victoria's Riflebird, Fernwren, Tooth-billed Bowerbird and the Lesser Sooty Owl. An additional species, the Golden Bowerbird, has been previously recorded in the vicinity. Of the 13 species of rainforest endemics, only the Atherton Scrubwren is not likely to be present.

Of ten subspecies endemic to north Queensland (Crome & Nix, 1991) nine were observed within the study area during this study. These were the northern subspecies of King parrot, Pale-yellow Robin, Yellow-breasted Boatbill, Grey Fantail, Eastern Whipbird, Brown Warbler, Northern Catbird, Satin Bowerbird and Boobook Owl (Crome & Nix, 1991).

REPTILES

Reptiles recorded during the study area surveys are listed in Appendix 1. The 38 species observed represent 59% of the 64 species recorded from the study area and its immediate environs. It is likely that a large number of reptile species present in the study area were not recorded because of their cryptic behaviour and lower activity levels in the dry season. Nevertheless, the species list in Tables 6 represent a substantial diversity of reptiles, distributed fairly evenly among wooded habitats.

AMPHIBIANS

Amphibian diversity appears to be highest in the open forest/woodland sites, primarily the riparian sub-sites, but this result could change considerably if a wet season amphibian survey was undertaken. Despite the rather poor conditions for observing amphibians, 16 species were recorded for the study area (Appendix 1) with Queensland Museum records increasing the total to 22 species. Most species were recorded in the riparian zones and at dams. However, it is likely that in the early wet season greater numbers of frogs would be observed in the areas away from permanent creeks.

No rare or uncommon species of amphibians were recorded. However, two species of rainforest endemic frogs were recorded (*Cophixalus ornatus* and *Sphenophryne robusta*), and two other species have been recorded previously and are likely to be present (*Nyctimistes dayi* and *Mixophyes schevilli*).

FISH

Fish species recorded in the two surveys are shown in Appendix 1. All, apart from the Eel, are

regarded as principal freshwater species, meaning that they undergo their whole life cycle in fresh water. The eel is diadromous, i.e. it has to migrate to the sea to breed.

Diversity at each site varied according to the size of the stream. In the small rainforest streams either no fish were found (site 11) or only the Purple-spotted Gudgeon occurred (site 10). This is similar to the pattern in other rainforest streams: for example, other than the eel, there are no fish in Birthday Creek (R.G. Pearson, unpubl. data) and only the gudgeon in Yuccabine Creek (Pearson et al., 1986). Further downstream, the sites had a larger complement of fish species with the addition rather than replacement of species - as is the case elsewhere, eg. the Annan River, near Cooktown (Hortle & Pearson, 1990).

It is of interest to compare the diversity of fishes between systems. This is best done using principal freshwater species, and by referencing the sizes of catchment areas, because larger catchments tend to accommodate more species (Welcomme, 1979). The area of the Star catchment sampled was about 1100km², that of Keelbottom Creek also about 1100km², and that of the upper Fanning River about 200km² (Qld Water Res. Comm. data). The fish survey recorded, respectively, 10, 8 and 8 principal freshwater species from these systems, and a total of 11 species. This compares with 12 species in the Black and Alice Rivers (about 300km²) near Townsville (Beumer, 1980) and 15 species in the Annan River (about 1000km²) (Hortle & Pearson, 1990). These figures are based on two years' monthly sampling of five sites in the Black/Alice and two sets of samples from 17 sites in the Annan. Comparison with middle Burdekin River samples (Pearson, 1991a) shows that there are only a few extra species recorded or missing from the river.

Given the different sampling intensities and catchment areas of the different systems, it appears that diversity of the fish fauna in the study area compares favourably with other stream systems in northern Queensland. Most of the species recorded have a broad distribution in eastern or northern Australia. Allen (1989) lists species within different status categories (endangered, vulnerable, potentially threatened, indeterminate, restricted and uncertain). The only species to appear on any of these lists and in the records from the study area streams is the Small-headed Grunter, which is listed as restricted. This species is only known from the Burdekin River system. It was not collected during the present survey, but Pusey (pers. comm.) has collected it from Run-

ning River, near the study area, and Pearson (1991b) recorded it from the middle Burdekin River. Otherwise there is no indication of any species of threatened status in the study area. However, samples of gudgeons, provisionally ascribed to *Hypseleotris compressa*, are currently under review.

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Part 1. Mammal species of the study area. The table lists numbers observed during the April/May field trips (nos. before the "f") and the August/September field trips (nos. after the "f"). A - Open woodland (Ironbark) in the southern study area, B - Open woodland (Ironbark) northern study area, C - Open Eucalypt forest (High Range training area), D - Wet sclerophyll/mixed open forest at the R.A.A.F. training area at Bluewater State forest, E - Transitional area between the Wet sclerophyll forest of site D and the open woodland of site B. Observational techniques include E - Elliot traps, C - Cage traps, P - Pits traps, H - by hand, S - spotlighting/miscellaneous observation, F - faecal pellets, M - mist netting, * - presence recorded, but not counted. Species names follow Ingram & Raven (1991).

SPECIES	COMMON NAME		A	B	C	D	E
Tachyglossidae							
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	S	-/1	-/-	-/-	-/-	-
Dasyuridae							
<i>Antechinus flavipes</i>	Yellow-footed Antechinus	EPHS	-/-	-/-	-/-	2/1	1
Peramelidae							
<i>Isodon macrourus</i>	Northern Brown Bandicoot	CES	-/-	2/2	1/5	-/3	-
<i>Perameles nasuta</i>	Long-nosed Bandicoot	CS	-/-	-/-	-/-	3/2	2
Phascolarctidae							
<i>Phascolarctus cinereus</i>	Koala	S	-/-	3/-	-/-	-/-	-
Petauridae							
<i>Petaurus breviceps</i>	Sugar Glider	S	1/2	-/1	1/1	-/1	1
<i>Petaurus norfolcensis</i>	Squirrel Glider	S	-/-	-/-	7/2	-/-	-
Pseudocheiridae							
<i>Petauroides volans</i>	Greater Glider	S	3/4	5/10	15/12	-/-	5
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	S	-/-	-/-	19/15	-/-	1
Phalangeridae							
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	SC	1/1	1/-	19/17	-/-	3
Potoroidae							
<i>Aepyprymnus rufescens</i>	Rufous Bettong	CS	1/6	3/7	-/-	-/-	1
Macropodidae							
<i>Macropus agilis</i>	Agile Wallaby	S	5/1	-/-	-/-	-/-	-
<i>Macropus giganteus</i>	Eastern Grey Kangaroo	S	6/5+	-/20	2/*	-/-	-
<i>Macropus parryi</i>	Whiptail Wallaby	S	-/2	-/3	-/-	-/-	-
<i>Macropus robustus</i>	Wallaroo	S	-/2	1/-	2/*	-/-	-
<i>Petrogale assimilis</i>	Allied Rock Wallaby	CSF	-/3	-/-	1/5	-/-	-
<i>Wallabia bicolor</i>	Swamp Wallaby	S	-/1	-/-	-/-	-/-	-
Pteropidae							

SPECIES	COMMON NAME		A	B	C	D	E
<i>Nyctimene robinsoni</i>	Queensland Tube-nosed Bat	M	1/-	-/-	-/-	-/-	-
<i>Pteropus alecto</i>	Black Flying-fox	S	1/-	-/*	-/-	-/-	-
<i>Pteropus scapulatus</i>	Little Red Flying-fox	S	-/1	-/*	-/6	-/3	-
<i>Syconycteris australis</i>	Queensland Blossom-bat	M	-/-	-/-	-/-	-/1	-
Mollossidae							
<i>Mormopterus loriae</i>	Little Northern Mastiff-bat	M	3/-	-/-	-/-	-/-	
Rhinolophidae							
<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	H	-/-	-/-	-/1	-/-	-
<i>Rhinolophus philipinensis</i>	Large-eared Horseshoe-bat	M	-/-	-/-	-/1	-/-	-
Vespertilionidae							
<i>Chalinobius gouldii</i>	Gould's Wattled Bat	M	4/4	-/-	-/3	-/-	-
<i>Chalinobius morio</i>	Chocolate Wattled Bat	M	-/1	-/-	-/-	-/-	-
<i>Chalinobius nigrogriseus</i>	Hoary Bat	M	3/2	-/-	-/-	-/-	-
<i>Miniopterus australis</i>	Little Bent-wing Bat	M	-/-	-/-	-/1	1/1	-
<i>Miniopterus schreibersii</i>	Common Bent-wing Bat	HM	1/1	-/-	-/2	-/3	-
<i>Myotis adversus</i>	Pond Bat	M	6/-	-/-	-/-	-/2	2
<i>Nyctophilus bifax</i>	North-Queensland Long-eared Bat	M	1/-	-/-	-/1	-/1	2
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	M	-/-	-/3	-/-	-/-	-
<i>Scoteanax rueppellii</i>	Greater Broad-nosed bat	M	8/-	-/-	-/-	-/-	-
<i>Scotorepens balstoni</i>	Western Broad-nosed bat	M	-/1	-/1	-/-	-/-	-
<i>Scotorepens sanborni</i>	Little Northern Broad-nosed bat	M	-/1	-/1	-/-	-/-	-
Leporidae							
<i>Oryctolagus cuniculus</i>	Rabbit	S	5/2	-/2+	1+/*	-/-	-
Muridae							
<i>Hydromys chrysogaster</i>	Water Rat	CS	3/*	4+/*	2/2	-/1	-
<i>Melomys burtoni</i>	Grassland Melomys	E	-/-	-/-	4/2	3/2	-
<i>Melomys cervinipes</i>	Fawn-footed Melomys	CE	-/-	-/-	9/6	16/12	-
<i>Pseudomys gracilicaudatus</i>	Eastern Chestnut Mouse	E	2/2	1/1	3/2	-/-	-/3
<i>Rattus fuscipes</i>	Bush Rat	EC	-/-	-/-	-/-	28/9	-
<i>Rattus lutreolus</i>	Swamp Rat	E	-/-	-/-	-/-	3/2	-
<i>Rattus rattus</i>	Black Rat	ECS	4/-	-/-	1/1	-/-	-
<i>Uromys caudimaculatus</i>	White-tailed Rat	CSE	-/-	-/-	-/-	5+/-	-
<i>Zyromys argurus</i>	Common Rock-rat	E	-/-	-/-	4/5	-/-	-
Canidae							
<i>Canis familiaris dingo</i>	Dingo	S	*/*	1/*	1/-	-/-	-
Felidae							

APPENDIX 1 cont.

SPECIES	COMMON NAME		A	B	C	D	E
<i>Felis catus</i>	Feral Cat	S	-/1	-/*	-/-	-/-	-
Equidae							
<i>Equus caballus</i>	Feral Horse	S	-/-	-/-	-/*	-/-	-
Suidae							
<i>Sus scrofa</i>	Feral Pig	SF	*/*	*/*	*/*	*/*	*

Part 2. Bird species of the study area. The index of abundance is based on the following criteria: (-) not observed at this site; 1 - observed on one occasion during the field trip; 2 - observed several times; 3 - common, observed most days; 4 - abundant, observed a number of times every day, usually at several different places. Names follow Ingram & Raven (1991). For further explanation see Part 1.

SPECIES	COMMON NAME		A	B	C	D
Casuaridae						
<i>Casuaris casuaris</i>	Southern Cassowary		-/-	-/-	-/-	-/1
<i>Dromaius novaehollandiae</i>	Emu		-/2	1/2	-/-	1
Podicipedidae						
<i>Podiceps cristatus</i>	Crested Grebe					
<i>Poliiocephalus poliiocephalus</i>	Hoary-headed Grebe		1/1	1/1	-/-	-/-
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe		2/1	1/1	-/1	-/-
Phalacrocoracidae						
<i>Phalacrocorax carbo</i>	Great Cormorant					
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant		-/-	3/1	-/2	1/-
<i>Hypoleucos sulcirostris</i>	Little Black Cormorant		-/-	1/1	-/-	-/-
Anhingidae						
<i>Anhinga novaehollandiae</i>	Australian Darter		-/1	1/1	-/2	-/-
Ardeidae						
<i>Casmerodius alba</i>	White Egret		1/1	1/1	-/-	-/-
<i>Egretta intermedia</i>	Plumed Egret		3/1	2/1	-/-	-/-
<i>Ardea ardea</i>	White-faced Heron		-/-	-/-	-/3	1
<i>Ardea pacifica</i>	White-necked Heron		1/1	1/1	1/-	-/1
<i>Butor flavicollis</i>	Black Bittern		1/-	-/-	-/-	-/-
<i>Nycticorax nycticorax</i>	Nankeen Night Heron		-/-	-/1	-/-	-/2
Threskiornithidae						
<i>Platalea flavipes</i>	Yellow-billed Spoonbill		1/1	1/-	-/-	-/-
<i>Platalea regia</i>	Royal Spoonbill		-/-	-/-	-/1	-/-
<i>Threskiornis spinicollis</i>	Straw-necked Ibis		-/1	2/3	-/1	-/-
Anatidae						
<i>Anas gracilis</i>	Grey Teal		1/-	1/1	-/-	-/-
<i>Anas superciliosa</i>	Black Duck		1/-	3/1	2/2	-/-
<i>Aythya australis</i>	White-eyed Duck		-/1	-/1	-/-	-/-
<i>Chenonetta jubata</i>	Wood Duck		2/-	1/1	1/1	-/-
<i>Dendrocygna arcuata</i>	Wandering Whistling Duck		2/-	2/1	2/-	-/-

SPECIES	COMMON NAME		A	B	C	D
<i>Nettion coromandelianus</i>	White Pygmy-Goose		1/-	-/1	-/-	-/-
Accipitridae						
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk		-/-	-/-	-/-	1/-
<i>Accipiter fuscatus</i>	Brown Goshawk		-/-	-/-	1/1	1/-
<i>Accipiter novaehollandiae</i>	Grey Goshawk		-/-	-/-	-/-	1/1
<i>Aquila audax</i>	Wedge-tailed Eagle		2/2	-/-	2/2	-/-
<i>Aviceda suberitana</i>	Crested Hawk		1/-	3/1	-/-	1/-
<i>Circus assimilis</i>	Spotted Harrier					
<i>Elanus notatus</i>	Black-shouldered Kite		-/1	-/-	1/-	-/-
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle		-/-	1/1	-/-	1
<i>Hieraaetus morphnoides</i>	Little Eagle		-/1	-/-	1/1	1
<i>Milvus migrans</i>	Fork-tailed Kite		-/-	-/1	1/1	-/-
<i>Haliastur sphenurus</i>	Whistling Kite		1/2	3/3	1/1	-/-
Falconidae						
<i>Falco berigota</i>	Brown Falcon		1/-	1/1	1/1	-/-
<i>Falco cenchroides</i>	Nankeen Kestrel		1/1	1/2	1/2	-/-
<i>Falco hypoleucos</i>	Grey Falcon		-/-	-/-	-/-	-/-
<i>Falco longipennis</i>	Little Falcon		-/-	1/-	-/-	-/-
Megapodidae						
<i>Alectura lathami</i>	Brush Turkey		-/-	-/-	-/1	2/1
Phasianidae						
<i>Synides australis</i>	Brown Quail		-/-	1/2	1/1	-/1
Gruidae						
<i>Grus rubicundus</i>	Brolga		-/-	1/-	-/-	-/-
Rallidae						
<i>Fulica atra</i>	Eurasian Coot		1/1	-/1	-/-	-/-
<i>Gallinula tenebrosa</i>	Dusky Moorhen		1/1	1/1	-/1	-/-
<i>Rallina tricolor</i>	Red-necked Crake		-/-	-/-	-/-	-/1
Onidae						
<i>Ardeotis australis</i>	Australian Bustard		-/-	-/-	1/1	-/-
Jacaniidae						
<i>Irediparra galinae</i>	Comb-crested Jacana		1/-	1/1	-/-	-/-
Burhinidae						
<i>Burhinus grallarius</i>	Bush Thick-knee		2/-	-/1	1/2	-/2
Charadriidae						
<i>Elseornis melanops</i>	Black-fronted Plover		1/-	-/-	-/-	-/-
<i>Vanellus miles</i>	Masked Lapwing (Plover)		1/-	-/3	1/-	-/-
Columbidae						
<i>Chalcophaps indica</i>	Green-winged Pigeon		-/-	-/-	-/-	-/2
<i>Columba leucomela</i>	White-headed Pigeon		-/-	-/-	-/-	1/-
<i>Geopelia pluvialis</i>	Peaceful Dove		-/-	2/3	3/3	-/-
<i>Oxyphaps lophotes</i>	Crested Pigeon		4/-	4/4	1/1	-/-
<i>Petrophassa scripta</i>	Squatter Pigeon		-/-	2/3	1/1	-/-

APPENDIX 1 cont.

SPECIES	COMMON NAME		A	B	C	D
<i>Todirhamphus macleayi</i>	Forest Kingfisher		-/-	-/-	2/2	-/2
<i>Todirhamphus pyrrhopygius</i>	Red-backed Kingfisher		-/-	1/-	-/-	-/-
<i>Todirhamphus sanctus</i>	Sacred Kingfisher		1/-	1/-	-/1	-/-
Meropidae						
<i>Merops ornatus</i>	Rainbow Bee-eater		2/-	-/-	3/-	1/3
Pittidae						
<i>Pitta versicolor</i>	Noisy Pitta		-/-	-/-	-/-	1/2
Campephagidae						
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-Shrike		2/2	3/1	3/2	-/1
<i>Coracina papuensis</i>	Little Cuckoo-Shrike		2/3	1/-	-/1	1/2
<i>Lalage leucomela</i>	Varied Triller		-/-	-/-	-/-	1/1
Orthonychidae						
<i>Orthonyx spaldingii</i>	Northern Logrunner		-/-	-/-	-/-	3/2
<i>Psophodes olivaceus</i>	Eastern Whipbird		-/-	-/-	-/-	4/2
Pomatostomidae						
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler		1/3	1/2	-/-	-/-
Sylviidae						
<i>Cincloramphus mathewsi</i>	Rufous Songlark		2/1	1/-	-/-	-/-
<i>Megalurur timoriensis</i>	Tawny Grassbird		-/-	-/-	-/-	-/-
Maluridae						
<i>Malurus melanocephalus</i>	Red-backed Wren		1/-	-/-	3/3	-/2
Acanthizidae						
<i>Acanthiza katherina</i>	Mountain Thornbill		-/-	-/-	-/-	1/-
<i>Acanthiza nana</i>	Little Thornbill		1/3	1/2	-/-	-/-
<i>Oreoscopus gutturalis</i>	Fernwren		-/-	-/-	-/1	-/-
<i>Gerygone fusca</i>	Western Warbler		1/-	-/-	-/-	-/-
<i>Gerygone mouki</i>	Brown Warbler		-/-	-/-	-/-	3/-
<i>Gerygone olivacea</i>	White-throated Warbler		-/-	-/1	-/1	-/-
<i>Gerygone palpebrata</i>	Fairy Warbler		-/-	-/-	-/1	1/1
<i>Sericornis citreogularis</i>	Yellow-throated Scrubwren		-/-	-/-	-/-	-/1
<i>Sericornis frontalis</i>	White-browed Scrubwren		-/-	-/-	-/-	1/1
<i>Sericornis magnirostris</i>	Large-billed Scrubwren		-/-	-/-	-/-	1/1
Monarchidae						
<i>Arses kaupi</i>	Pied Monarch		-/-	-/-	-/-	4/1
<i>Machaerirhynchus flaviventer</i>	Yellow-breasted Boatbill		-/-	-/-	-/-	1/1
<i>Monarcha trivirgatus</i>	Spectacled Monarch		-/-	-/-	-/1	4/3
<i>Myiagra cyanoleuca</i>	Satin Flycatcher		-/-	-/-	1/1	1/-
<i>Myiagra rubecula</i>	Leadend Flycatcher		-/-	1/-	1/4	-/2
<i>Rhipidura fuliginosa</i>	Grey Fantail		4/4	4/3	4/4	4/2
<i>Rhipidura leucophrys</i>	Willie Wagtail		3/3	4/3	2/-	-/-

SPECIES	COMMON NAME		A	B	C	D
<i>Macropygia phasianella</i>	Brown Pigeon		-/-	-/-	-/-	1/-
<i>Phaps chaloptera</i>	Common Bronzewing		-/2	1/-	-/-	-/-
<i>Ptilinopus magnificus</i>	Wompoo Pigeon		-/-	-/-	-/-	-/2
<i>Ptilinopus superbus</i>	Purple-crowned Pigeon		-/-	-/-	-/-	-/2
Loriidae						
<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet		-/-	-/-	1/2	-/2
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet		3/4	1/3	3/3	1/3
Cacatuidae						
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo		3/3	4/3	-/1	1/3
<i>Calyptorhynchus magnificus</i>	Red-tailed Black Cockatoo		1/1	-/-	1/-	2/1
Psittacidae						
<i>Alisteria scapularis</i>	King Parrot		-/-	-/-	-/-	-/1
<i>Aprosmictus erythropterus</i>	Red-winged Parrot		1/2	1/1	-/1	-/-
<i>Platycercus adscitus</i>	Pale-headed Rosella		3/2	4/3	3/2	-/-
<i>Platycercus elegans</i>	Crimson Rosella		-/-	-/-	-/-	1/-
Cuculidae						
<i>Centropus phasianinus</i>	Pheasant Coucal		2/1	3/3	2/1	-/1
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo		-/-	-/-	-/1	1/-
<i>Chrysococcyx russatus</i>	Rufous-breasted Bronze-Cuckoo		-/-	-/-	-/-	1/-
<i>Chrysococcyx lucidus</i>	Shining Bronze-Cuckoo		-/-	-/-	-/-	1/-
<i>Cacomantis flabelliformis</i>	Fantail Cuckoo		-/-	1/1	1/-	4/2
Tytonidae						
<i>Tyto alba</i>	Barn Owl		-/1	-/-	-/-	-/1
<i>Tyto multipunctata</i>	Lesser Sooty Owl		-/-	-/-	-/-	1/2
Strigidae						
<i>Ninox connivens</i>	Barking Owl		-/-	-/1	-/-	-/1
<i>Ninox boobook</i>	Boobook		2/2	-/1	-/-	-/1
Podargidae						
<i>Podargus papuensis</i>	Papuan Frogmouth		-/-	-/-	-/-	1/-
<i>Podargus strigoides</i>	Tawny Frogmouth		-/1	1/1	-/1	-/-
Aegothelidae						
<i>Aegotheles cristatus</i>	Australian Owlet Nightjar		2/-	3/1	-/-	-/-
Caprimulgidae						
<i>Caprimulgus macrurus</i>	Large-tailed Nightjar		-/-	-/-	-/-	-/2
<i>Eurospododus mystacalis</i>	White-throated Nightjar		-/-	-/-	-/-	-/2
<i>Eurostopodus argus</i>	Spotted Nightjar		-/1	-/-	1/-	-/-
Alcedinidae						
<i>Ceyx azureus</i>	Azure Kingfisher		2/-	3/1	1/3	1/1
<i>Ceyx pusillus</i>	Little Kingfisher		-/-	1/1	-/-	-/1
<i>Dacelo leachii</i>	Blue-winged Kookaburra		1/-	-/3	1/3	-/-
<i>Dacelo novaeguineae</i>	Laughing Kookaburra		3/2	3/3	2/3	-/2

APPENDIX I cont.

SPECIES	COMMON NAME		A	B	C	D
<i>Melophaga notata</i>	Yellow-spotted Honeyeater		-/-	-/-	-/1	1/1
<i>Melophaga lewinii</i>	Lewins Honeyeater		-/-	-/-	-/-	4/3
<i>Melithreptus albogularis</i>	White-throated Honeyeater		2/4	4/2	4/4	-/-
<i>Melithreptus lunatus</i>	White-naped Honeyeater		-/-	-/-	-/-	-/1
<i>Myzomela obscura</i>	Dusky Honeyeater		-/-	-/1	-/1	-/3
<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater		-/1	-/1	1/1	-/3
<i>Philemon argenteiceps</i>	Silver-crowned Friarbird		1/-	-/-	-/-	-/-
<i>Philemon citreogularis</i>	Little Friarbird		-/4	-/3	-/-	-/-
<i>Philemon corniculatus</i>	Noisy Friarbird		-/4	-/3	-/3	-/-
<i>Ramsayornis modestus</i>	Brown-backed Honeyeater		-/-	-/-	-/2	-/-
<i>Xanthotis macleayana</i>	Macleay's Honeyeater		-/-	-/-	-/-	2/2
Estrildidae						
<i>Lonchura punctulata</i>	Spice Finch		-/-	1/-	-/-	-/-
<i>Neochmia temporalis</i>	Red-browed Finch		-/-	-/-	3/3	1/-
<i>Taeniopygia bichenovii</i>	Double-barred Finch		1/-	-/-	-/-	-/-
Oriolidae						
<i>Oriolus sagittatus</i>	Olive-backed Oriole		-/1	1/-	-/-	3/1
Dicruridae						
<i>Dicrurus bracteatus</i>	Spangled Drongo		-/-	-/1	1/-	-/1
Grallinidae						
<i>Grallina cyanoleuca</i>	Peewee		3/4	4/3	2/3	-/-
Corcoracidae						
<i>Corcorax melanorhamphos</i>	White-winged Chough		-/-	2/1	1/2	-/-
<i>Struthidea cinerea</i>	Apostlebird		4/2	2/2	-/1	-/-
Artamidae						
<i>Artamus leucorhynchus</i>	White-breasted Woodswallow		-/-	-/1	-/-	1/1
Cracticidae						
<i>Cracticus nigrogularis</i>	Pied Butcherbird		2/3	4/4	1/2	-/-
<i>Cracticus torquatus</i>	Grey Butcherbird		3/3	3/3	1/2	-/-
<i>Gymnorhina tibicen</i>	Australian Magpie		4/4	4/4	3/4	-/-
<i>Strepera graculina</i>	Pied Currawong		1/1	1/1	3/3	2/2
Ptilonorhynchidae						
<i>Ailuroedus melanotis</i>	Spotted Catbird		-/-	-/-	-/-	1/-
<i>Chlamydera nuchalis</i>	Great Bowerbird		3/1	1/-	-/1	-/-
<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird		-/-	-/-	-/-	1/-
Paradisaeidae						
<i>Ptiloris victoriae</i>	Victoria's Riflebird		-/-	-/-	-/-	3/3
Corvidae						

SPECIES	COMMON NAME		A	B	C	D
<i>Rhipidura rufifrons</i>	Rufous Fantail		-/-	-/-	-/-	1/3
Eopsaltridae						
<i>Eopsaltria australis</i>	Eastern Yellow Robin		-/-	-/-	-/1	4/3
<i>Heteromyias cinereifrons</i>	Grey-headed Robin		-/-	-/-	-/-	1/1
<i>Microeca flavigaster</i>	Lemon-breasted flycatcher		-/-	-/-	-/3	-/-
<i>Microeca leucophaea</i>	Jacky Winter		2/-	-/-	-/-	-/-
<i>Tregellasia capito</i>	Pale-yellow Robin		-/-	-/-	-/-	2/3
Pachycephalidae						
<i>Colluricincla boweri</i>	Bowers Shrike-Thrush		-/-	-/-	-/-	1/-
<i>Colluricincla harmonica</i>	Grey Shrike-Thrush		-/-	-/-	-/-	2/1
<i>Colluricincla megahyncha</i>	Rufous Shrike-Thrush		-/-	-/-	-/-	4/4
<i>Pachycephala pectoralis</i>	Golden Whistler		-/-	-/-	-/-	4/3
<i>Pachycephala rufiventris</i>	Rufous Whistler		2/4	1/2	4/4	1/1
Neosittidae						
<i>Daphoenositta chrysoptera</i>	Sittella		-/-	-/-	-/-	1/-
Climacteridae						
<i>Climacteris picumnus</i>	Brown Treecreeper		-/-	1/-	-/-	-/-
<i>Cornobates leucophaea</i>	White-throated Treecreeper		-/-	-/-	-/-	4/3
Dicaeidae						
<i>Dicaeum hirundinaceum</i>	Mistletoebird		-/1	-/-	-/-	3/1
Pardalotidae						
<i>Pardalotus punctatus</i>	Spotted Pardalote		-/-	-/-	-/-	2/1
<i>Pardalotus striatus</i>	Striated Pardalote		4/4	4/4	4/3	2/-
Zosteropidae						
<i>Zosterops lateralis</i>	Silvereye		-/-	-/-	-/-	3/3
Meliphagidae						
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill		-/-	-/-	-/-	-/1
<i>Cissomela pectoralis</i>	Banded Honeyeater		-/-	-/-	-/2	-/-
<i>Entomozon cyanotis</i>	Blue-faced Honeyeater		4/4	3/3	2/2	-/-
<i>Meliphaga chrysops</i>	Yellow-faced Honeyeater		-/-	-/-	-/-	1/3
<i>Meliphaga flavescens</i>	Yellow-tinted honeyeater		-/-	-/-	-/-	-/-
<i>Meliphaga flava</i>	Yellow Honeyeater		-/-	-/-	1/-	-/-
<i>Meliphaga frenata</i>	Bridled Honeyeater		-/-	-/-	-/-	-/1
<i>Meliphaga fusca</i>	Fuscous honeyeater		-/-	-/-	-/-	-/-
<i>Lichmera indistincta</i>	Brown Honeyeater		-/-	-/1	1/3	1/2
<i>Manorina flavigula</i>	White-rumped Miner		2/4	4/3	-/-	-/-
<i>Manorina melanoccephala</i>	Noisy Miner		2/3	2/4	-/3	-/-

APPENDIX 1 cont.

SPECIES	COMMON NAME		A	B	C	D
<i>Corvus coronoides</i>	Australian Raven		-/3	-/-	-/-	-/-
<i>Corvus orru</i>	Australian Crow		4/3	4/3	3/3	-/2

Part 3. Reptiles of the study area. The index of abundance is based on the following criteria : (-) not recorded at this site; 1 - observed once during the field trip; 2 - observed several times; 3 - common, observed most days; 4 - abundant, observed a number of times every day, usually at several locations. For further explanation see Part 1. Species names follow Ingram & Raven (1991).

SPECIES	COMMON NAME		A	B	C	D	E
Gekkonidae							
<i>Diplodactylus steindachneri</i>		HP	1/1	-/-	-/-	-/-	HP
<i>Gehyra dubia</i>		H	-/1	2/1	1/1	-/-	-
<i>Heteronotia binoei</i>	Bynoe's Gecko	H	3/3	-/2	2/2	-/-	-
<i>Oedura castlenau</i>	Northern Velvet Gecko	H	-/-	2/2	-/-	-/-	-
Scincidae							
<i>Carlia rostralis</i>		H	-/-	-/-	-/-	-/-	1
<i>Carlia jarnoldae</i>		H	-/-	-/-	-/1	-/1	1
<i>Carlia munda</i>	HP	1/1	-/-	2/2	-/-	-	-
<i>Carlia mundivensis</i>		H	-/1	-/-	2/2	-/-	-
<i>Carlia rubigularis</i>		H	-/-	-/-	-/-	3/3	-
<i>Cryptoblepharus virgatus</i>		11	3/-	2/2	2/2	-/-	2
<i>Ctenotus spaldingi</i>		H	-/-	-/-	-/-	-/1	-
<i>Egernia striolata</i>	Tree Skink	H	-/-	1/-	-/-	-/-	-
<i>Sphenomorphus quoyii</i>	Water Skink	SH	-/-	-/-	-/-	1/2	-
<i>Lampropholis basiliscus</i>		H	-/-	-/-	-/-	1/1	-
<i>Lygisaurus foliorum</i>		H	-/-	-/-	-/-	-/1	-
<i>Menetia greyii</i>		HP	1/1	-/-	-/-	-/-	-
<i>Morethia taeniopleura</i>	Fire-tailed Skink	HP	3/1	-/-	3/2	-/-	-
Agamidae							
<i>Pogona barbata</i>	Bearded Dragon	HS	-/-	1/1	-/-	-/-	-
<i>Diporiphora australis</i>	Two-line Dragon	HS	-/-	-/-	1/1	-/-	-
<i>Physignathus lesueurii</i>	Water Dragon	HS	-/-	-/-	-/-	2/1	1
Varanidae							
<i>Varanus scalaris</i>	Spotted Tree-monitor	H	1/-	-/-	-/-	-/2	-
<i>Varanus varius</i>	Lace Monitor	H	-/-	-/-	-/1	-/1	1
Boidae							
<i>Aspidites melanocephalus</i>	Black-headed Python	H	1/-	-/-	-/-	-/-	-
<i>Morelia amethystina</i>	Amethystine Python	H	-/-	-/-	-/-	1/-	-
<i>Morelia maculosa</i>	Childrens Python	HS	2/-	-/-	-/-	-/-	-
Colubridae							
<i>Tropidonophis mairii</i>	Keelback	H	-/-	-/-	-/1	-/-	1
<i>Dendrelaphis punctulata</i>	Common Tree Snake	H	-/-	-/-	-/-	1/22	-

Elapidae							
<i>Demansia vestigiata</i>	Black Whipsnake	S	-/-	-/-	1/-	-/-	-
<i>Demansia psammophis</i>	Yellow-faced Whipsnake	H	-/-	-/-	-/-	1/22	-
<i>Furina ornata</i>	Orange-naped Snake	H	-/1	-/-	-/-	-/-	-
<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	SH	-/-	-/-	-/-	3/3	-
<i>Pseudonaja textilis</i>	Eastern Brown Snake	HS	2/-	-/-	-/-	-/-	-
<i>Rhinoplocephalus nigrescens</i>	Small-eyed Snake	H	-/-	-/-	-/-	-/1	-
Chelidae							
<i>Elseya latisternum</i>	Sawshell Tortoise	H	-/-	1/2	2/2	-/-	-
<i>Emydura kreftii</i>	Kreft's River Tortoise	H	-/-	1/2	1/1	-/-	-

Part 4. Frogs of the study area. Species names follow Ingram & Raven (1991). For further explanation see Part 1.

SPECIES	COMMON NAME		A	B	C	D
Bufonidae						
<i>Bufo marinus</i>	Cane Toad	HSP	4/4	4/4	4/4	4/4
Hylidae						
<i>Cyclorana novaehollandiae</i>		H	2/-	-/-	-/-	-/-
<i>Litoria albiguttata</i>	Green-stripe Frog	H	2/-	-/-	-/-	-/-
<i>Litoria caerulea</i>	Green Tree Frog	HSP	2/-	1/-	1/-	1/-
<i>Litoria inermis</i>		HS	3/3	3/3	1/1	-/-
<i>Litoria latopalmata</i>		H	-/-	-/-	-/2	-/-
<i>Litoria leseuri</i>	Stony-creek Frog	HSP	-/-	3/3	3/3	3/3
<i>Litoria nasuta</i>	Striped Rocket Frog	HS	-/-	-/2	2/-	3/3
<i>Litoria rothii</i>	Red-eyed Tree Frog	H	1/1	1/-	-/-	-/-
<i>Litoria rubella</i>	Naked Tree Frog	PH	3/-	-/-	-/-	-/-
Myobatrachidae						
<i>Limnodynastes ornatus</i>	Ornate Burrowing Frog	PHS	4/2	1/1	2/-	-/-
<i>Limnodynastes peronii</i>	Striped Marshfrog	H	-/-	-/2	-/-	-/2
<i>Limnodynastes tasmanicus</i>	Spotted Marshfrog	11	-/-	-/-	1/-	-/-
<i>Uperoleia luhomoda/minula</i>		PH	3/-	-/-	-/-	-/-

[illegible]